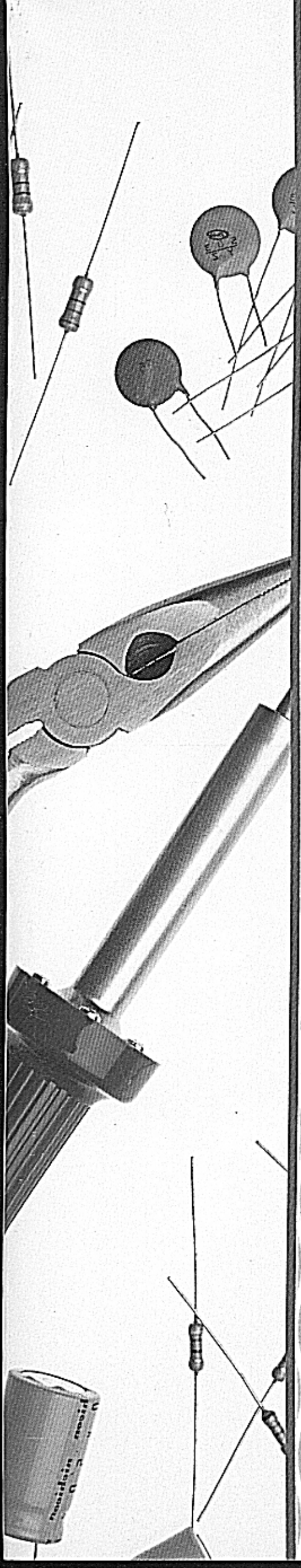


SAVE A BUNDLE

BUILD YOUR OWN

Low-Cost Signal Generator

Delton T. Horn

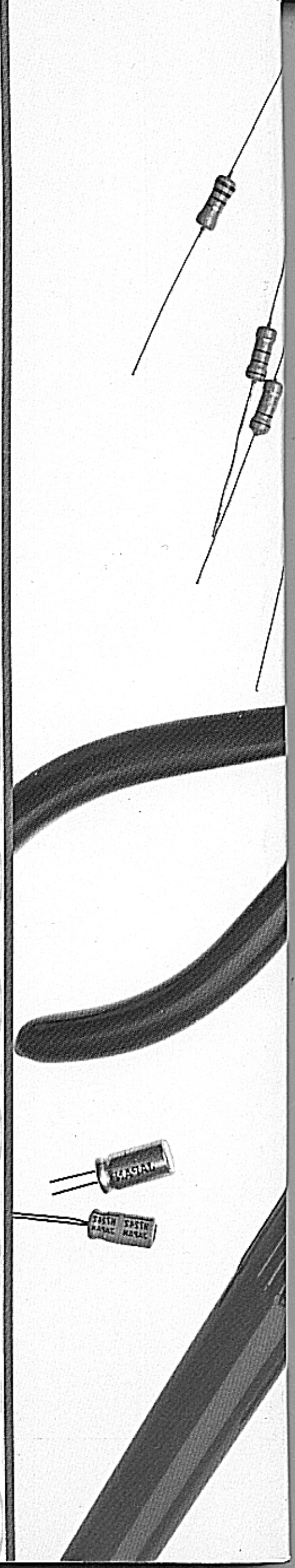
Improve your electronics skills and save money by building your own signal generator

A signal generator is an important piece of electronic test equipment, but commercial signal generators can cost a bundle. With this book, you can learn how to generate almost any kind of electronic signal you need without emptying your wallet.

Filled with interesting and useful subassembly projects, ***Build Your Own Low-Cost Signal Generator*** features one complete project—an inexpensive signal generator with a wide array of electronics applications, including troubleshooting, repair, and circuit design. Respected electronics author Delton T. Horn provides you with complete circuits and parts lists for generating signals of all types, ranging from direct current to complex digital synthesis.

Some of the signals you'll learn about include:

- Sine waves
- Amplitude and frequency modulation
- Op amp-generated square and rectangular waves
- Sawtooth and staircase waves
- Special-purpose waveforms
- Pink-noise and white-noise generators
- IC-based signal generators



$19.95 U.S.A. 0694

ISBN 0-07-030429-7

9 780070 304291 90000

TAB Books
Division of McGraw-Hill, Inc.
Blue Ridge Summit, PA 17294-0850

Contents

Projects *ix*

Introduction *xi*

1 dc power supplies *1*

The basics of power-supply circuits *2*
- Half-wave rectifiers *2*
- Full-wave rectifiers *5*
- Bridge rectifiers *6*

Voltage regulation *9*
Dual-polarity power supplies *18*
Safety and power supplies *18*
Designing a power-supply circuit *20*
Using standard voltage-regulator ICs *25*
Changing the output voltage *28*
Current regulation *34*
Project #1—Multiple-output, dual-polarity power supply *37*
Project #2—Variable-output, current-limited power supply *40*

2 Audio oscillators *43*

LC parallel-resonant tanks *44*
The Hartley oscillator *47*
The Colpitts oscillator *49*
The ultra-audion oscillator *50*
The Clapp oscillator *52*
The Armstrong oscillator *52*
The crystal oscillator *53*
The Pierce oscillator *58*
Op amp oscillators *59*
Dedicated ICs *65*
Project #3—Sine-wave audio oscillator *66*

3 Rectangle-wave, square-wave, and pulse-wave generators 69

Duty cycle *70*
Harmonics *73*
Transistor rectangle-wave generator circuits *77*
Op amp square-wave generators *84*
Op amp rectangle-wave generators *87*
555 astable multivibrators *91*
The LM3909 LED flasher/oscillator *95*
Project #4—Variable-frequency/variable duty-cycle rectangle-wave generator *97*

4 Function generators 103

Standard waveforms *103*
Op amp function generators *105*
555 timer function generator *110*
UJT VCO *113*
Dedicated function-generator ICs *126*
Project #5—Three-waveform function generator *136*
Project #6—Sweep-signal generator *140*

5 Pink-noise generators 147

White noise *148*
Pink noise *150*
What is noise good for? *150*
Noise-generator circuits *155*
Project #7—Two-way noise generator *159*
The MM5837N/S2688 noise-generator IC *161*
Random voltage generation *164*
Project #8—Random voltage source *168*

6 Complex waveform generators 171

Amplitude modulation *171*
Ring modulation *176*
Frequency modulation *176*
Additive and subtractive synthesis *181*
Modified sawtooth-wave generator *190*
Staircase-wave generators *193*
Project #9—Up/down staircase-wave generator *197*
Project #10—555 unusual waveform generator *197*
Project #11—Programmable waveform generator *201*

7 RF oscillators and signal generators *205*
Stray capacitances *205*
RF signal testing *210*
Inside an RF signal generator *212*
Project #12—Unmodulated RF signal generator *215*
Project #13—Modulated RF signal injector *218*

8 Digital signal generation *221*
Simple digital clock circuits *222*
Dedicated clock ICs *227*
Variable duty-cycle rectangle-wave generators *228*
Digital VCOs *233*
The CD4046 PLL *234*
Project #14—Digital odd-waveform signal generator *244*
Frequency multiplication and division *247*
Synthesizing analog waveforms digitally *256*
Project #15—Digital sine-wave generator *264*
Project #16—Precision digital clock *267*

Index *271*

Introduction

Few electronics systems would be of much use without signals of some sort flowing through them. Sometimes the signal is an electrified version of some non-electronic parameter. For example, a PA amplifier system uses voice and other sound signals converted into electrical form by a microphone. An electronic light meter's signal is the electrical equivalent of the intensity of the light shining on some sort of photosensor.

Often, though, the signals needed are purely electronic in origin. The circuitry must create its own signals from scratch. There are countless types of electrical signals that we might want to generate. Simply put, an electronically-generated signal may be either a dc voltage or current, or an ac waveform of some type. Both dc and ac signal generation are covered thoroughly in this book. Chapter 1 deals with dc signals, and the rest of the book explores various ac signals, including the most popular and widely used—the sine wave (chapter 2), the rectangle wave and its special forms, the square wave and the pulse wave (chapter 3), the triangle wave, the sawtooth wave, and the staircase wave.

Odd and exotic special purpose waveforms are also covered, along with white noise and pink noise. Function generators, which can generate two or more different waveforms within a single circuit, are discussed in chapter 4. White-noise and pink-noise generators are the subjects of chapter 6.

Chapter 7 explores various ways to generate nonstandard, complex ac waveforms. Amplitude modulation, frequency modulation, additive synthesis and subtractive synthesis are among the techniques discussed here. The special problems and considerations involved when working with RF (radio frequency) signals are explored in chapter 7.

Finally, chapter 8 examines the various, and often surprising ways that ac signals can be generated by digital circuitry. Usually digital circuitry only works with rectangle waves of some sort, but techniques for digitally synthesizing other analog waveforms will also be considered in this chapter.

In addition to the theoretical background and circuit design tips, this book also features sixteen inexpensive but useful projects, including sound generators, power

supplies, and test equipment. Certainly, none of these projects will put any commercial manufacturers of such equipment out of business. For the most part, we won't be dealing with super-precision specifications in any of these projects. But the specs are still surprisingly good for such easy, minimal-cost projects. They should be good enough for most typical hobbyist applications. The limitations of any given project will be mentioned in the text, where relevant.

You can spend hundreds of dollars to buy a deluxe commercial signal generator. Or, you can build any one of these projects for less than $25, and it will do almost as good of a job for most noncritical applications.

With this book as your guide, you should be able to generate almost any electronic signal you'll ever need, without having to spend a bundle.